Stories of Other Worlds

Crater Diameter Prediction Lab

Earth Science Essentials-Advanced

by Russ Colson

The first objective of this lab is to design and do experiments and construct graphs that allow you to make predictions about the size of impact craters given the mass and velocity of the impactor. (The ability to predict future events is a key test of the validity of science)

A secondary objective of your experiments is to show whether or not the density of the projectile makes any difference in crater size beyond what can be accounted for by velocity (drop height) and mass.

These experiments won't apply directly to hypersonic impacts, such as most primary impacts on planets, but they give an idea of how various important variables affect the crater size. I want you to try to design experiments that will allow you to predict the size of crater formed by an impactor dropped from some height that you will only learn once you have completed your experiments.

We are going to use fine, uniform sand (pure white, washed silica sand, not play sand or leveling sand), a basin to hold the sand (needs to be at least a few inches deep--such as a bowl or small plastic container), and three different masses of impactor (provided in your lab kit). You will need a tape measure to measure the drop-distance for each experiment and a short ruler to measure the size of each impact crater. Final values will be reported in centimeters.

1 glass marble, 0.5" diameter, mass = 2.91g
smaller steel marble, 0.25" diameter, mass = 0.94g
larger steel marble, 0.375" diameter, mass = 3.31g

Hints as you design your experiments:

- Think about how to constrain your experiments such as to look at the effects of one variable at a time.
- Think about how to conduct experiments so that results are reproducible (that is, the experiment can be repeated with more or less the same results). This requires that each experiment be done with the same initial conditions and in the same way. For each set of conditions, do the experiment 3 times or so to actually measure how reproducible your results are.
- Design an experiment to determine how crater size depends on velocity of the impactor.
- Plot a graph which shows the experimentally determined empirical relationship between velocity and crater size.

- Does the crater diameter vary linearly with increasing drop height (related to velocity) (that is, if drop height increases by a factor of 4, does the crater diameter increase by a factor of 4?
- Consider the physical process that causes the relationship between velocity and size.
- Do you expect on this basis that the lines or curves should pass through the origin?

Grading:

Your grade will be based on
1) A test where you will predict crater size for 6 different situations of impactor size and drop height--this test will be timed and you will have only two minutes to predict each crater.

Half of your grade for this lab will be determined based on the accuracy of your predictions (the test of real science is often its ability to make predictions of future events). You will need to predict the size of crater for 6 events. Your grade for this half of the lab will be + 8pnts for each crater you got right within +/-15%, plus 2 points.

NOTE: I will measure the diameter of the craters from the highest point on one side of the crater to the highest point on the other side--doing repetitions and taking the average. The sand-depth will always be large compared to the depth of the crater. You will be given the drop height in centimeters (cm) and must give the crater diameter in cm.

2) The other half of your grade will be based on your conclusion about whether density affects crater size in some way that is not accounted for by velocity and mass--along with the graphs and explanations that support your conclusion. You grade will be based mainly on the clarity and completeness of your explanation.

Your report should make perfectly clear what your conclusion is and why you come to that conclusions, clearly referring to your experimental results (graphs) where appropriate.